

CLAIMS

1. A system for etching of semiconductor or other type of substrates or wafers comprising:

a reaction chamber having a port for exhausting gases from the chamber;

5 a source of gas or gases, at least one of which contains a species capable of etching the substrate or thin film material;

a pedestal for supporting the substrate within the chamber;

means for ionizing the gas(es) within the chamber to form a plasma;

and

10 a segmented gas injection element which is adjacent to or immersed in the plasma and which is separated from the substrate by a distance approximately less than its size from which the distribution of the flow or mixture of gas(es) can be altered spatially proximate to the substrate in a controlled and variable way, for each wafer or substrate if desired, by having
15 a varying amount or mixture of gas flow to some or all of the segments such as to cause the etching rate distribution to vary across the substrate.

2. The system of Claim 1 wherein the flows of gas(es) to the injection segments may be changed automatically without human intervention.

3. The system of Claim 1 wherein the object of the variation in the distribution of gaseous injection is to provide a process rate (either etching or deposition) which is non-uniform with a desired distribution or where some property of the etching process is non-uniform with a desired distribution.

4. The system of Claim 1 wherein the reactive specie(s) producing etching or deposition is formed in the reactor chamber by the action of a plasma.

5. The system of Claim 1 wherein the purpose of the alteration of the distribution of gas flows to the segments is to cause the etching rate to be non-uniform in accordance with the wafer or substrate thickness.
6. The system of Claim 1 wherein the change in gas flows to some segments of the gas injector effects a greater change in the etch rate in those areas of the wafer which are closer to those segments than in other areas of the wafer.
7. The system of Claim 1 wherein there are at least two segments.
8. The system of Claim 1 wherein one or more etchant gas(es) are increased in flow to increase the etch rate of a corresponding section(s) of a wafer.
9. The system of Claim 1 wherein the etchant gas(s) is decreased in flow to decrease the etch rate of a corresponding section(s) of a wafer.
10. The system of Claim 1 wherein a diluent(s) or energy absorbing gas is added to the etchant gas to decrease the etch rate of a corresponding section(s) of a wafer.
11. The system of Claim 1 wherein a diluent(s) is added and the etchant gas(s) is decreased in flow to cause a decrease in the etch rate of a corresponding section(s) of a wafer.
12. The system of Claim 1 wherein an additional gas (to the mixture of gases used for etching) is added in controlled amounts to some or all segments which amounts may vary from one segment to another causing a decrease in the etching rate of some parts of a wafer or substrate.

13. The system of Claim 4 in which the means of plasma formation is a capacitively coupled, radio frequency electric discharge.

14. The system of Claim 13 in which the wafer holding pedestal is substantially parallel to a counter-electrode.

15. The system of Claim 13 in which the wafer holding pedestal is slightly tilted from parallelism to the counter-electrode, with the angle of tilt of the counter-electrode relative to the wafer holding pedestal being less than about a few degrees.

16. The system of Claim 13 where the source of radio frequency power is connected to either the wafer supporting pedestal or the counter-electrode or both.

17. The system of Claim 1 in which the gap between the wafer holding pedestal and the counter-electrode is less than 0.5 times the radius of the wafer-holding electrode or the counter-electrode

18. The system of Claim 1 wherein the gas(s) flow is interrupted for some amount of time to cause a decrease in the etch rate of a corresponding section(s) of a wafer.

19. In semiconductor wafer etching equipment, a segmented shower head where the flow of gas can be altered separately and individually to three or more segments to affect a change in the etch rate of the wafer in areas corresponding to those segments.

20. The wafer etching equipment of Claim 19 wherein there are at least two segments.

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21. The wafer etching equipment of Claim 19 wherein the etchant gas(s) is increased in flow to some set of segments to increase the etch rate of corresponding area(s) of a wafer.

22. The wafer etching equipment of Claim 19 wherein a diluent(s) or etching suppressant gas(es) is/are added to the etchant gas to decrease the etch rate of a corresponding section(s) of a wafer.

23. The wafer etching equipment of Claim 19 wherein a diluent(s) or etching suppressant gas(es) is/are added and the etchant gas(s) is decreased in flow to cause a decrease in the etch rate of a corresponding section(s) of a wafer.

24. The wafer etching equipment of Claim 19 wherein the gas(s) flow is interrupted for some amount of time to cause a decrease in the etch rate of a corresponding section(s) of a wafer.

25. The wafer etching equipment of Claim 19 wherein the segmented shower head is used in conjunction with wafer thickness measuring instruments to predetermine the wafer thickness and uniformity, and the gas flow of the segmented shower head is adjusted to compensate for the non-uniformity of the wafer.

26. The wafer etching equipment of Claim 19 wherein the segmented shower head is used in conjunction with wafer thickness measuring instruments to measure the thickness of the wafer after etching only a portion of intended material to be removed, to determine the effectiveness of the selected flow rates on the desired etch uniformities or non-uniformities desired, for the purpose of fine tuning such flow settings for part or all of the remainder of the wafer's etch.

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5 27. The wafer etching equipment of Claim 19 wherein the segmented shower head is used in conjunction with wafer thickness measuring instruments to measure the thickness of the wafer after etching is complete, to determine the effectiveness of the selected flow rates on the desired etch uniformities or non-uniformities desired, for the purpose of fine tuning such flow settings on subsequent wafers.

28. In semiconductor wafer deposition equipment, the use of a segmented shower head where the flow of gas can be altered in some segments relative to the remaining segments to affect a change in the deposition rate of the areas of the substrate corresponding to such segments.

29. The wafer etching equipment of Claim 28 wherein there are at least two segments.

30. The wafer etching equipment of Claim 28 wherein the deposition gas(s) is increased in flow to increase the deposition rate of a corresponding section(s) of a wafer.

31. The wafer etching equipment of Claim 28 wherein the deposition gas(s) is decreased in flow to some set of segments to decrease the deposition rate on corresponding area(s) of a wafer.

32. The wafer etching equipment of Claim 28 wherein a diluent(s) is added to the deposition gas to decrease the deposition rate of a corresponding section(s) of a wafer.

33. The wafer etching equipment of Claim 28 wherein a diluent(s) is added and the deposition gas(s) is decreased in flow to cause a decrease in the deposition rate of a corresponding section(s) of a wafer.

34. The wafer etching equipment of Claim 19 wherein the gas(s) flow is interrupted for some amount of time to cause a decrease in the deposition rate of a corresponding section(s) of a wafer.

35. In semiconductor wafer deposition equipment, a segmented shower head where the flow of gas can be altered separately and individually in two or more segments to affect a change in the deposition rate of the segments.

36. The wafer deposition equipment of Claim 35 wherein there are at least two segments.

37. The wafer deposition equipment of Claim 35 wherein the deposition gas(s) is increased in flow to increase the deposition rate of a corresponding section(s) of a wafer.

38. The wafer deposition equipment of Claim 35 wherein the deposition gas(s) is decreased in flow to decrease the etch rate of a corresponding section(s) of a wafer.

39. The wafer deposition equipment of Claim 35 wherein a diluent(s) is added to the deposition gas to decrease the deposition rate of a corresponding section(s) of a wafer.

40. The wafer deposition equipment of Claim 35 wherein a diluent(s) is added and the deposition gas(s) is decreased in flow to cause a decrease in the deposition rate of a corresponding section(s) of a wafer.

41. The wafer deposition equipment of Claim 35 wherein the gas(s) flow is interrupted for some amount of time to cause a decrease in the deposition rate of a corresponding section(s) of a wafer.

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42. The wafer deposition equipment of Claim 35 wherein the segmented shower head is used in conjunction with film thickness measuring instruments to determine the film thickness and uniformity, and the gas flow of the segmented shower head is adjusted to compensate for the non-uniformity of the film deposited on the wafer.

43. The wafer deposition equipment of Claim 35 wherein the segmented shower head is used in conjunction with film thickness measuring instruments to measure the thickness of the deposited film after depositing only a portion of intended material to be deposited, in order to determine the effectiveness of the selected flow rates on the desired deposition uniformities or non-uniformities desired, for the porpoise of fine tuning such flow settings for part or all of the remainder of the wafer's deposition.

44. The wafer deposition equipment of Claim 35 wherein the segmented shower head is used in conjunction with film thickness measuring instruments to measure the thickness of the deposited film after deposition is complete, to determine the effectiveness of the selected flow rates on the desired deposition uniformities or non-uniformities desired, for the porpoise of fine tuning such flow settings on subsequent wafers.

45. A system for thin film deposition on semiconductor or other type of substrates or wafers comprising:

- a reaction chamber with a port for exhausting gases from the chamber;
- a supply of gas or gases, at least one of which contain(s) a species capable of forming a deposit on the substrate or thin film material;
- a pedestal for supporting a substrate within the chamber; and
- a segmented gas injection element which is adjacent to or immersed in the gas and which is separated from the substrate by a distance approximately less than its size from which the distribution of the flow or mixture of gas(es) can be altered spatially proximate to the substrate in a controlled and variable way, for each wafer or substrate if desired, by having

a varying amount or mixture of gas flow to some or all of the segments such as to cause the deposition rate distribution to vary across the substrate.

46. The system of Claim 45 wherein the flows of gas(es) to the injection segments may be changed automatically without human intervention.

47. The system of Claim 45 wherein the object of the variation in the distribution of gaseous injection is to provide a process rate (deposition) which is non-uniform with a desired distribution or where some property of the deposited film is non-uniform with a desired distribution.

48. The system of Claim 45 wherein the reactive specie(s) producing etching or deposition is formed in the reactor chamber by the action of a plasma.

49. The system of Claim 45, wherein the purpose of the alteration of the distribution of gas flows to the segments is to cause the deposition rate to be non-uniform in accordance with some property of the wafer or substrate.

50. The system of Claim 45 wherein the change in gas flows to some segments of the gas injector effects a greater change in the deposition rate in those areas of the wafer which are closer to those segments than in other areas of the wafer.

51. The system of Claim 45 wherein there are at least two segments.

52. The system of Claim 45 wherein one or more depositing gas(es) are increased in flow to increase the deposition rate of a corresponding section(s) of a wafer or substrate.

53. The system of Claim 45 wherein the depositing gas(s) is decreased in flow to decrease the deposition rate of a corresponding section(s) of a wafer or substrate.

54. The system of Claim 45 wherein a diluent(s) or energy absorbing gas is added to the depositing gas to decrease the deposition rate of a corresponding section(s) of a wafer or substrate.

55. The system of Claim 45 wherein a diluent(s) is added and the depositing gas(s) is decreased in flow to cause a decrease in the etch rate of a corresponding section(s) of a wafer.

56. The system of Claim 45 wherein an additional gas (to the mixture of gases used for deposition) is added in controlled amounts to some or all segments which amounts may vary from one segment to another causing a decrease in the deposition rate of some parts of a wafer or substrate.

57. The system of Claim 45 in which the means of plasma formation is a capacitively coupled, radio frequency electric discharge.

58. The system of Claim 57 in which the wafer holding pedestal is substantially parallel to a counter-electrode.

59. The system of Claim 57 in which the wafer holding pedestal is slightly tilted from parallelism to the counter-electrode, with the angle of tilt of the counter-electrode relative to the wafer holding pedestal being less than about a few degrees.

60. The system of Claim 57 where the source of radio frequency power is connected to either the wafer supporting pedestal or the counter-electrode or both.

61. The system of Claim 45 in which the gap between the wafer holding pedestal and the counter-electrode is less than 0.5 times the radius of the wafer-holding electrode or the counter-electrode

62. The system of Claim 45 wherein the gas(s) flows to some or all segments are interrupted for some amount of time to cause a decrease in the deposition rate of corresponding section(s) of a wafer.

63. In semiconductor wafer deposition equipment, the use of a segmented shower head where the flow of gas can be altered separately and individually to three or more segments to affect a change in the deposition rate of the wafer in areas corresponding to those segments.

64. The wafer deposition equipment of Claim 63 wherein there are at least two segments.

65. The wafer deposition equipment of Claim 64 wherein the depositing gas(s) is increased in flow to some set of segments to increase the etch rate of corresponding area(s) of a wafer.

66. The wafer deposition equipment of Claim 64 wherein a diluent(s) is added to the depositing gas to decrease the deposition rate of a corresponding section(s) of a wafer.

67. The wafer deposition equipment of Claim 64 wherein a diluent(s) is added and the etchant gas(s) is decreased in flow to cause a decrease in the deposition rate of a corresponding section(s) of a wafer.